WATeRS: A portal for water quality information products from operational remote sensing

Eleveld, M.A.; Wagtendonk, A.J.; Pasterkamp, R.; de Reus, N.O.; Bonn, B.; Scepek, S.; Laanen, M.L.

2006

document version
Publisher's PDF, also known as Version of record

WATeRS

A portal for water quality information products from operational remote sensing; http://ivm10.ivm.vu.nl/mapserver/waters

Marieke Eleveld, Alfred Wagtendonk, Reinold Pasterkamp, Nils de Reus (IVM), Betty Bonn, Susanne Scepek (Geodan IT), Marnix Laanen (WaterInsight)

Projectnummer 52319SPI

ISBN 90-5192-031-8

R-06/06

September 26, 2006

This report was commissioned by: NIVR

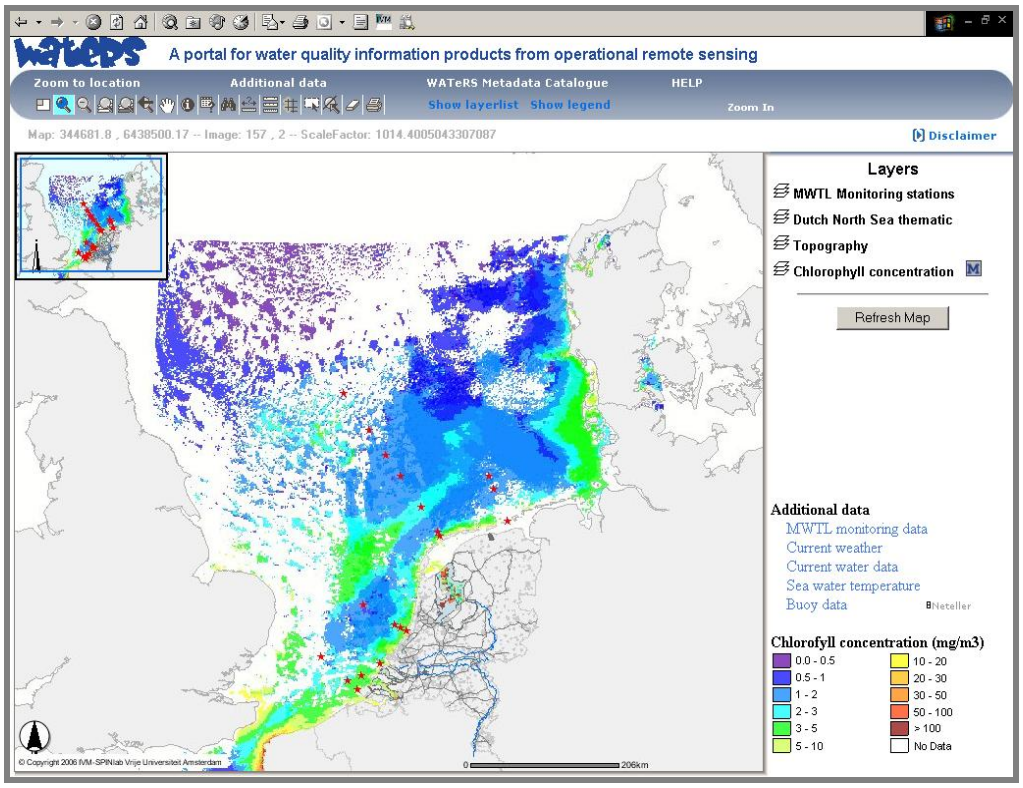
It was internally reviewed by dr. Hans van der Woerd, externally by dr. Raymond Sluiter (NIVR)

IVM

Institute for Environmental Studies
Vrije Universiteit
De Boelelaan 1087
1081 HV Amsterdam
The Netherlands

Tel. ++31-20-5989 555
Fax. ++31-20-5989 553
E-mail: info@ivm.falw.vu.nl

Screendump of the WATeRS portal
http://ivm10.ivm.vu.nl/mapserver/waters



Project partners

Institute for Environmental Studies/ Vrije Universiteit

Geodan IT

Water Insight

P.O. Box 35

2600 AA Delft

The Netherlands

Kluyverweg 1

2629 HS Delft

The Netherlands

Tel. +31 (0)15 278 80 25

Fax +31 (0)15 262 30 96

NATIONAL USER SUPPORT PROGRAMME (NUSP)

2001-2005

http://www.ao-go.nivr.nl

The National User Support Programme 2001-2005 (NUSP) is executed by the Netherlands Agency for Aerospace Programmes (NIVR) and the SRON Netherlands Institute for Space Research. The NUSP is financed from the national space budget. The NUSP subsidy arrangement contributes to the development of new applications and policy-supporting research, institutional use and use by private companies.

The objectives of the NUSP are:

- To support those in the Netherlands, who are users of information from existing and future European and non-European earth observation systems in the development of new applications for scientific research, industrial and policy research and operational use;
- To stimulate the (inter)national service market based on space-based derived operational geo-information products by means of strengthening the position of the Dutch private service sector;
- To assist in the development of a national Geo-spatial data and information infrastructure, in association with European and non-European infrastructures, based on Dutch user needs;
- To supply information to the general public on national and international space-based geo-information applications, new developments and scientific research results.

Contents

Abstract

This report compliments the WATeRS portal, a web map server available at *http://ivm10.ivm.vu.nl/mapserver/waters*. This is a result from an NIVR sponsored project, which aimed to initiate the WATeRS portal, an information service that provides products from remote sensing (RS) of water quality (WQ) projects, and to firmly establish its position within the WQ field.

WQ parameters exhibit important spatio-temporal variability that can be well detected with RS monitoring techniques. WQ information derived from RS techniques is not always incorporated into monitoring practices, because the information is not easily accessible and often lacks context. With WATeRS we provide easy interactive access to RS data in its spatial context.

The WATeRS portal is based on standard technology that complies with OGC and W3C standards, and that is compatible with standard Rijkswaterstaat software. Web-mapping applications offer integrated contextual information and RS-products to (a.o.) water managers. WATeRS is a customised ArcIMS-application with a WMS ArcIMS-OGC connector. It is linked to Dutch and European geo-data infrastructures such as the INfrastructure for SPatial InfoRmation in Europe (INSPIRE) initiative from the European Commission. We converted satellite data (in scientific formats) to GIS formats, and serve these data in near-real time on the Internet in a Web-mapping application. This enables users to interactively explore the remote sensing products, and to seamlessly combine the data with other data with a geographic component.

This is illustrated in the rest of this report, which consists of thee parts. The first part, mainly deals with creating the WATeRS portal at VU-IVM. The second part deals with the external testing at Geodan. The third part looks at the costs of continuation of the service, a joint study of WaterInsight and Geodan. Chapter 4 summarises our conclusions.

Executive summary

WATeRS, a portal for water quality information products from operational remote sensing http://ivm10.ivm.vu.nl/mapserver/WATerS serves near-real time MODIS L2 information open and interactively available for all on the Internet.

It is based on automated conversion of satellite data (in scientific formats) to GIS formats, and comprises a customised ArcIMS-application with a WMS ArcIMS-OGC connector.

The main result from a user point of view is the information service that enables users to interactively explore remote sensing products, and to seamlessly combine this data with other data with a geographic component. On the long term this service might encourage the use of remote sensing RS (products) for, a.o., monitoring and planning purposes.

The main result from a technical point of view is the WATeRS portal itself, http://ivm10.ivm.vu.nl/mapserver/WATeRS, a novel customisation of an ArcIMS-application with a WMS ArcIMS-OGC connector having the following characteristics. The WATeRS portal:

1. Is a near-real time interactive, easily online accessible map service of water quality information from operational remote sensing, based on off the shelf technology that complies with open standards;
2. Serves verifiable results via a GIS based map service with a metadata catalogue that provides, amongst others, full lineage of the CHL maps;
3. Was customised to create a simple, clear and intuitive user interface, grid-cell query functionality, and automated archiving of produced map results.

Particularly users of environmental and oceanographical data have multidisciplinary interests, and would like to combine different types of data of a certain geographic area. WATeRS allows integration and comparison of different datasets on different levels, and is targeted towards visualisation and grid query. For users also holding their own GIS data, we facilitate combination of distributed datasets in our map service.

A number of developments made in this project can be used for other (water quality) parameters and sensors. The robust service has been used for automated data collection since Jan 2005, has a growing user group, and is open. However, the project for the development of WATeRS is ending and WATeRS should be embedded into a larger framework to ensure continuity in NRT updating, maintenance, and stimulate further developments

1. WATeRS Cookbook

Eleveld, M.A., Wagtendonk, A.J., de Reus, N.O. & Pasterkamp, R.

A report of activities for: WP 1 User requirements analysis, WP 2 Preparing remote sensing products, WP 3 Preparing meta-information & WP 4 Web-implementation.

For more information please contact: marieke.eleveld@ivm.vu.nl or alfred.wagtendonk@ivm.vu.nl

1.2 Introduction

Water quality (WQ) parameters exhibit important spatio-temporal variability that can be well detected with remote sensing (RS) monitoring techniques. WQ information derived from RS techniques is increasingly used in monitoring.

Monitoring of chlorophyll-a (CHL) concentrations in the North Sea is important for assessing changes in the environmental state of this European regional sea. CHL is a green pigment in phytoplankton (algae), which is the main source of food for life in the sea. Bloom of phytoplankton/algae can also be harmful (Van der Woerd et al., 2005), and high CHL concentrations can indicate high nutrient levels and thus it is an important water quality parameter.

The MOderate Resolution Imaging Spectroradiometer (MODIS) is a 36-band spectrometer observing the land, atmosphere, and oceans within a wavelength range of en 412 to 14 385 nm (Esaias et al., 1998). MODIS is part of a continuous programme and is, therefore, suitable for monitoring.

Historically monitoring comprised of bi-weekly or monthly in situ sampling from ships at the location of standard (MWTL) monitoring stations. Currently, also additional experiments with buoys and remote sensing (Eleveld & van der Woerd, 2006) have been carried our, and also cruises with a Ferrybox are foreseen. The acceptation of remote sensing techniques in monitoring is facilitated when the derived information is easily accessible and placed in context. Therefore, this was aimed at in the WATeRS project.

1.2.1 Objectives

The objectives of the project were to initiate the WATeRS portal, an information service that provides products from RS of WQ projects, and to firmly establish its position within the WQ field.

This cookbook aims to explain the major steps that were taken to develop the WATeRS map portal services.

1.2.2 User Requirements

Main users currently identified are involved in WQ monitoring, and policy preparation. Both groups are interested in the near-real time possibilities for scientific / monitoring cruise planning.

User requirements are disparate, but the following overall tendencies can be perceived (Eleveld et al., 2004):

- All users of RS of WQ information (incl. Rijkswaterstaat) are building geodata infrastructures;
- Water quality information derived from satellites should be available in a in a format that complies with these information structures;
- There is a need for near-real time information for monitoring (particularly on chlorophyll) and time series;
- Request for context through metadata & additional data (GIS layers).

1.2.3 Outline

The main process flow from satellite image to GIS format ans online GIS service is given in Figure 1.1. The Architecture in shown in Figure1.2. The different elements of this flow and architecture are explained in the following paragraphs.

1.3 From satellite data to image server

1.3.1 MODIS data and file formats

The data comprised of MODIS near-real time CHL data from *http://oceancolor.gsfc.nasa.gov* and links to additional datasets for the North Sea. The data are obtained through the Ocean Color Web Data Subscription *http://oceancolor.gsfc.nasa.gov/cgi/ocdatasubscription.cgi that* stages MODIS-Aqua data on an FTP site. The specifications are given in the Box below.

Subscriptor: reinold.pasterkamp@ivm.falw.vu.nl
Start Date : May 4 2004 12:00AM
Stop Date : Continuous
North Latitude : 57
South Latitude : 51
West Longitude : 0
East Longitude : 9
Stage L1A : NO
Stage L2 : YES
Stage MET/OZONE: NO
Stage ATT/EPH : NO
Stage Quick Look : YES
Stage Refined : NO
Stage Extract : NO
Extract must fit : NO
Stage Day : YES

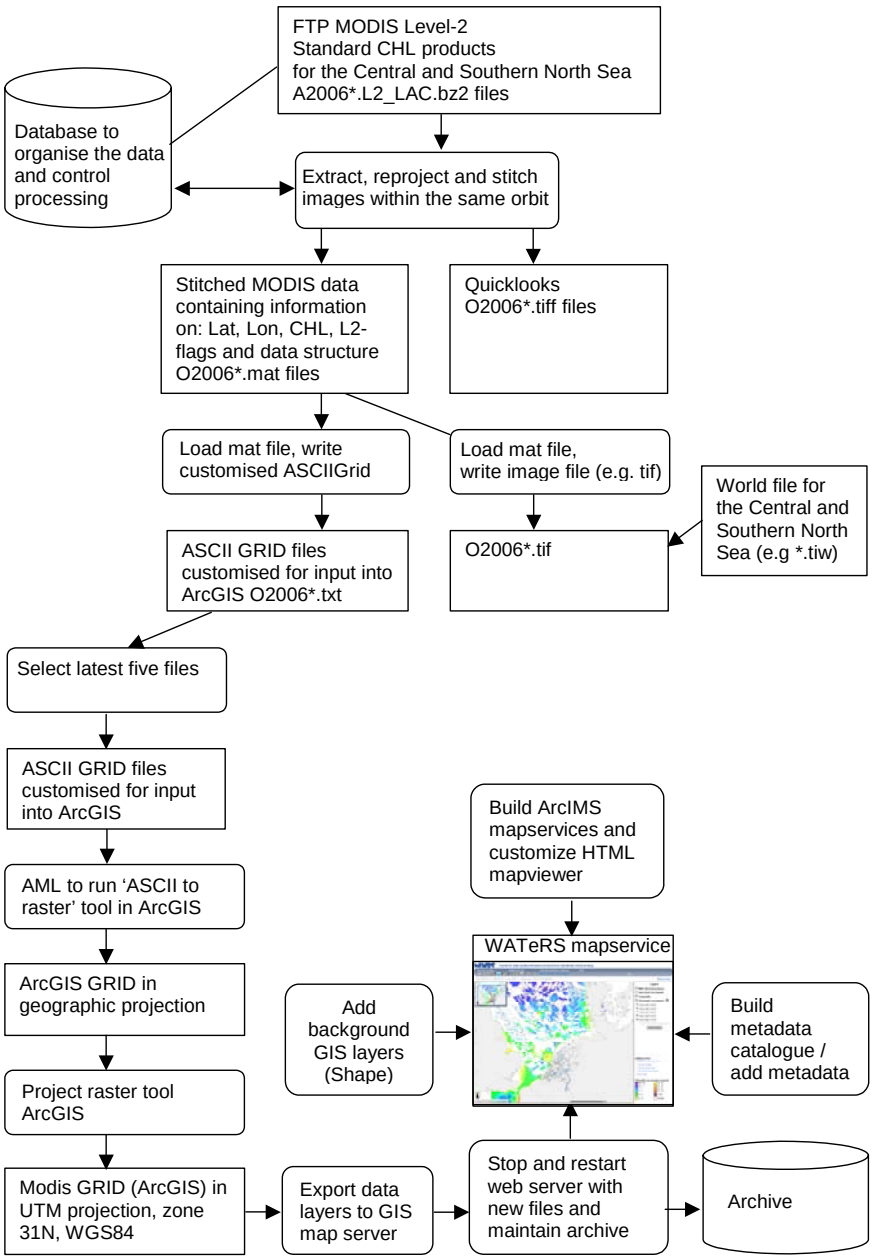
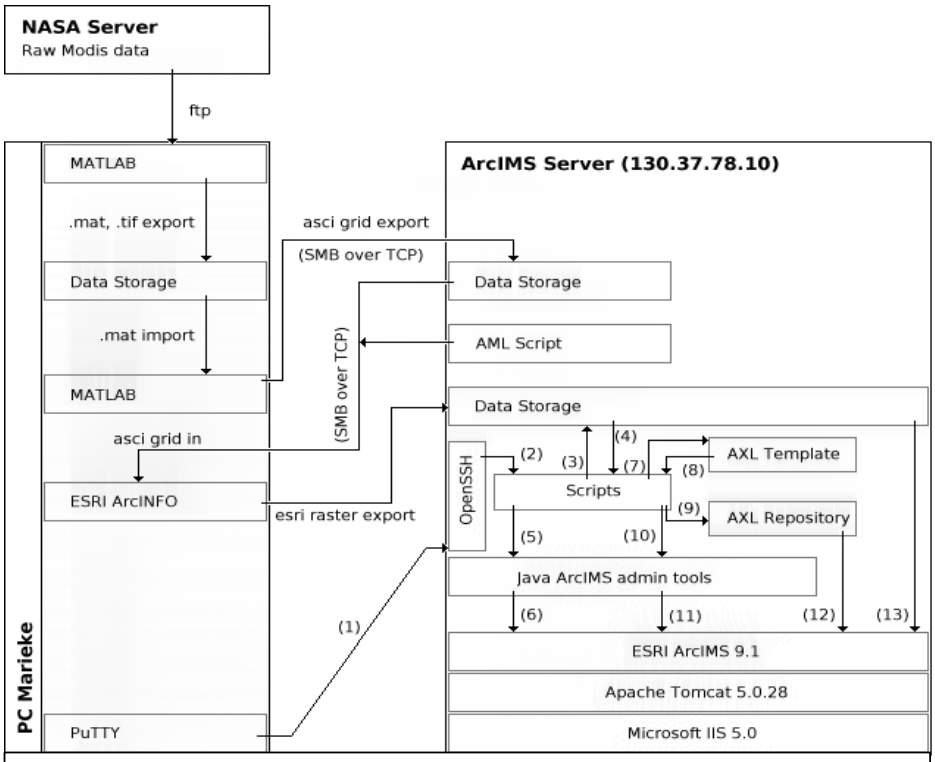


Figure 1.1. Processing flow.



Legend

1) PuTTY client connects to OpenSSH server using SSH2 protocol on port 22, authenticates using a private-public key pair with 1024 bits length RSA based keys. Once authenticated, automatically executes a script call on the server - see (2)

(2) SSH session invokes script "mapserviceupdate"

(3) Script "mapserviceupdate" sends a system command to retreive an index of available data

(4) A list of data is returned in response to (3). Control is returned to script "mapserviceupdate".

(5) A supporting script controlled by mapserviceupdate invokes the java runtime on the ArcIMS admin tool class, passing an ArcXML command file

(6) Java ArcIMS admin tools package sends 'Stop and Remove' order for the current instance of the WATERS service on the running ArcIMS 9.1 mapserver, then returns control to calling script from (5)

(7) and (8) Script invokes SED (unix stream editor) on a template AXL file that is to be combined with the list returned as (4) (two arrows shown because of the nature of stream editing)

(9) Results from stream edit operation are piped to file within the ArcIMS AXL repository folder

(10) Script invokes the java runtime on the ArcIMS admin tool class, passing an ArcXML command file

(11) Java ArcIMS admin tools package sends 'Add and Start' order to create a new updated instance of the WATERS mapservice on the running ArcIMS 9.1 mapserver, then returns control to calling script from (5) which self-terminates.

(12) Under instruction from the admin tools, ArcIMS does a one-time read of the AXL file that was produced from (9) and loads it into memory as the governing AXL instance for the WATERS mapservice. (It will be automatically loaded again in case of server reboot)

(13) When a map is requested, ArcIMS retrieves data from the data sources identified by the AXL loaded in (12)

Figure 1.2. Architecture.

1.4 From satellite data to image server

1.4.1 MODIS data and file formats

The data comprised of MODIS near-real time CHL data from *http://oceancolor.gsfc.nasa.gov* and links to additional datasets for the North Sea. The data are obtained through the Ocean Color Web Data Subscription *http://oceancolor.gsfc.nasa.gov/cgi/ocdatasubscription.cgi that* stages MODIS-Aqua data on an FTP site. The specifications are given in the Box below.

```
Subscriptor: reinold.pasterkamp@ivm.falw.vu.nl
Start Date                    : May 4 2004 12:00AM
Stop Date                     : Continuous
North Latitude                : 57
South Latitude      : 51
West Longitude      : 0
East Longitude      : 9
Stage L1A                     : NO
Stage L2                      : YES
Stage MET/OZONE: NO
Stage ATT/EPH     : NO
Stage Quick Look  : YES
Stage Refined                 : NO
Stage Extract                 : NO
Extract must fit    : NO
Stage Day                     : YES
```

Subsequently a Matlab program MODISonlineME.m © R. Pasterkamp customised by M. Eleveld connected with an Access database MODISonline.mdb © R. Pasterkamp was written to download A2006*.L2_LAC.bz2 files, geo-corrects them and output O2005*.1.mat and O2005*.1_QL.tiff files. These .mat file and a quicklook are described in the boxes on the next page.

```
File: 'G:\MODIS\MODISonline\O2005082132500.1.mat'
Contains: LAT, LON, fieldnames, list, z,
LAT, (defined as)
Columns 1 through 8
   50.0000   50.0100   50.0200   50.0300   50.0400   50.0500   50.0600   50.0700
until
Columns 697 through 701
   56.9600   56.9700   56.9800   56.9900   57.0000
LON, (defined as)
LON =
   -1.0000
   -0.9900
   -0.9800
until
9.9900
   10.0000
fieldnames
fieldnames =
    'l2_flags'    'chlor_a'
list,
list =
     orbitID: 'O2005082132500'
    granules: {'L:\MODIS\MODISonline\A2005082132500.L2_LAC.bz2'  [1x46 char]}
z,
z =


Quicklook: G:\MODIS\MODISonline\O2005082132500.1_QL.tiff
```

A reprojected picture using Matlab's pcolorm function from the Mapping Toolbox. (PCOLORM(lat,lon,map) warps a matrix map to a projected graticule mesh, thus allowing matrix surfaces to be **displayed** in a map projection. (Source: Matlab Help)

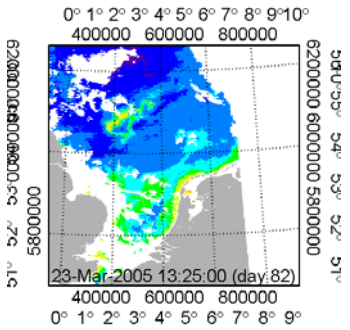


Figure 1.3. Quicklook.

1.4.2 Conversion

To create a customised ASCII grid

As the .mat file format produced in the initial stage of this process cannot be imported by any of the GIS used at IVM – SPINlab, we convert this file format first to an ASCII file format, so we can further process it in our GIS. The ASCII file must consist of header information containing a set of keywords, followed by cell values in row-major order. The file format is given in the box below:

<NCOLS xxx>
<NROWS xxx>
<XLLCENTER xxx | XLLCORNER xxx>
<YLLCENTER xxx | YLLCORNER xxx>
<CELLSIZE xxx>
{NODATA_VALUE xxx}
row 1
row 2
.
.
row n

where xxx is a number, and the keyword nodata_value is optional and defaults to -9999. Row 1 of the data is at the top of the grid, row 2 is just under row 1, and so on. (Source: ArcGIS Help)

A Matlab program exportGISAsciigridM.m © M.A. Eleveld was written to create these customised ArcGIS ASCII grid files and copy them to another location (SPINLab server).

Registering images (pictures) to a map

To copy the CHL data in the Matlab file to a tif Or use function exportGIStifM(A) to read multiple .mat files in, to write them to a customised ArcGIS tif format, and copy them to another location (SPINLab server). The referencing information should be given as a separate ascii file, a worldfile, *.tiw (tif worldfile). The contents are given in the box below.

0.01
0
0
-0.01
-1
57

With this ArcView/GIS can perform a six-parameter image-to-world affine transformation in the form of:
x1 = Ax + By + C and y1 = Dx + Ey + F
where
x1 = calculated x-coordinate of the pixel on the map
y1 = calculated y-coordinate of the pixel on the map
x = column number of a pixel in the image
y = row number of a pixel in the image
A = x-scale; dimension of a pixel in map units in x direction ((Source: ArcView Help)
B, D = rotation terms
C, F = translation terms; x,y map coordinates of the center of the upper-left pixel
E = negative of y-scale; dimension of a pixel in map units in y direction

From ASCII grid to ArcGIS ESRI grid

To convert Modis ASCII-file to GISraster (gridformat) in ArcGIS (ESRI) Open ArcGIS with ArcInfo license

Go to ArcToolbox

Open menu Conversion tools and run under To Raster the ASCII to Raster tool. Fill in location of the Input ASCII raster file (or browse to the location of this file). Fill in location of the Output raster file (or browse to the location of this file). Choose if output raster should be of the type integer or floating. Choose floating if you want to keep current accuracy or first multiply the grid with a factor 1000 and than choose for integer (if necessary this can also be done later on).

Press OK.

The grid you just created is still in geographic projection and must be (re)projected to the projection used in the project, Universal Tranverse Mercator: UTM-wgs84 zone 31N.

Open again ArcToolbox in ArcGIS with ArcInfo license.Open menu Data Management Tools.Open menu Projection and transformations. Open Menu Raster. Run Define Projection and select the earlier produced grid as input dataset. Choose the belonging coordinate system, by clicking on the menu right of the menubox:

- Choose in the displayed menu ‘select’ and go to ‘Geographic Coordinate systems’;
- Choose World and than WGS 1984.prj;
- Choose add and than OK.
  (if you get an error message that a projection is already defined for the grid, than remove the grid from the table of contents and carry out above steps again).

Now the geographic projection of the new grid has been defined and is ready for projection (as the geographic ‘projection’ is not a projection). Check if the projection data are now displayed in the properties of the datalayer (double click the layer in the table of contents and select the layer with the right mouse button and choose properties). Scroll down under the tab page Source until you reach the Spatial Reference information. Here you should find the earlier defined projection data.

Open again the menu Projection and transformations and run ‘Project raster’. Fill in the name and location of the input raster (you can also browse to it) and the output raster (ArcGIS already provides you with a name which you can use or change if desired). Select the Output coordinate system:

- Choose in the displayed menu ‘select’ en go to ‘Projected Coordinate systems’;
- Choose UTM and than WGS 1984;
- Choose WGS 1984 UTM zone 31N.prj (the Dutch UTM zone);
- Choose add and than OK;
- The default resampling technique and output cellsize can be adopted.

The projection to UTM is now carried out and the projected grid is automatically added to the present datasets. Check if the projection of the grid is correct, in other words if it overlays correctly with the other data layers that are in the same projection.

1.4.3 A legend colour scheme

The legend colours in ArcGIS/IMS can easily be adapted to the selected REVAMP color map.mat colour scheme.

kleurklasse	remarks	'from'	'to'	R	G	B	'H'	'S'	'V'	cmap=RGB/255		
1	wolken	-1	-1	0	0							
2	eigenlijk Inf-0.5	0.3	0.5	87	0	168	0.753	1	0.6588	0.3412	0	0.6588
3		0.5	1	0	0	255	0.6667	1	1	0	0	1
4		1	2	0	127.5	255	0.5833	1	1	0	0.5	1
5		2	3	0	255	255	0.5	1	1	0	1	1
6		3	5	0	255	0	0.3333	1	1	0	1	0
7		5	10	191.25	255	63.75	0.2222	0.75	1	0.75	1	0.25
8		10	20	255	255	0	0.1667	1	1	1	1	0
9		20	30	255	191.25	0	0.125	1	1	1	0.75	0
10		30	50	255	127.5	0	0.0833	1	1	1	0.5	0
11		50	100	255	63.75	0	0.0417	1	1	1	0.25	0
12	eigenlijk 100-In	100	200	140	0	0	0	1	0.549	0.549	0	0

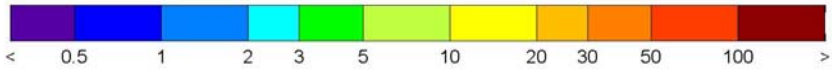


Figure 1.4. Legend (REVAMP colormap).

Open the layer properties menu of one of the Chlorophyll gridfiles and select the symbology tab. Choose for a classified legend and select a number of 11 classes (as in the colour scheme above), the type of classification doesn’t matter as you will determine the class breaks manually. Now fill in for each legend class the right class breaks by double clicking the present numbers in the range. Do the same for the labels. Double click the legend colours by doubleclicking them. Choose from the colour scheme the option ‘more colours’ and fill in the right RGB values (open the colour scheme above in an image processing programme to find the belonging RGB values). Press OK and save the layer configuration with the legend classes to a layer file, by right clicking the layer and choosing ‘save as layer file’. Open the next Chlorophyll grid layer and import the just saved layer file under the symbology tab to apply the same colour settings on the new grid file.

Rather than finding out the right way to write down the correct AXL code for this classification scheme, the quickest and easiest way to export these legend colour classifications to ArcIMS is to use the MXD to *.AXL extension for ArcGIS (MXDtoAXL.zip, Jeroen Ticheler, *http://arcscripts.esri.com*). This extension tool converts ArcMap views (all layers in the view) into AXL configuration files, both for shapefiles and for raster

files. Simply copy the desired section from the AXL file produced with this extension to your own AXL file on your ArcIMS server. The resulting (adapted) AXL code for one of the chlorophyll grid layers is given in Figure 2.5.

```
<LAYER name="Chlorofyl 2006067134000" type="image" id="chloro1" visible="true">
        <DATASET name="2006067134000" showcolormaplegend ="false" type="image" workspace="ws-1"/>
        <COORDSYS id="32631"/>
        <RASTER_RENDERER>
                <RASTER_RANGE color="86,0,164" lower="0" upper="0.5" equality="lower" transparency="0.7" label="0.0 - 0.5 Chl mg/m3"/>
                <RASTER_RANGE color="0,0,253" lower="0.5" upper="1" equality="lower" transparency="0.7" label="0.5 - 1 Chl mg/m3"/>
                <RASTER_RANGE color="0,128,255" lower="1" upper="2" equality="lower" transparency="0.7" label="1 - 2 Chl mg/m3"/>
                <RASTER_RANGE color="0,255,255" lower="2" upper="3" equality="lower" transparency="0.7" label="2 - 3 Chl mg/m3"/>
                <RASTER_RANGE color="0,255,0" lower="3" upper="5" equality="lower" transparency="0.7" label="3 - 5 Chl mg/m3"/>
                <RASTER_RANGE color="201,255,64" lower="5" upper="10" equality="lower" transparency="0.7" label="5 - 10 Chl mg/m3"/>
                <RASTER_RANGE color="255,255,0" lower="10" upper="20" equality="lower" transparency="0.7" label="10 - 20 Chl mg/m3"/>
                <RASTER_RANGE color="255,187,0" lower="20" upper="30" equality="lower" transparency="0.7" label="20 - 30 Chl mg/m3"/>
                <RASTER_RANGE color="255,128,0" lower="30" upper="50" equality="lower" transparency="0.7" label="30 - 50 Chl mg/m3"/>
                <RASTER_RANGE color="255,60,0" lower="50" upper="100" equality="lower" transparency="0.7" label="50 - 100 Chl mg/m3"/>
                <RASTER_RANGE color="140,0,0" lower="100" upper="300" equality="lower" transparency="0.7" label="> 100 Chl mg/m3"/>
                <RASTER_OTHER color="255,255,255" transparency="0" label="No Data"/>
        </RASTER_RENDERER>
        <IMAGEPROPERTIES transparency="0.7" transcolor="232,255,255"/>
</LAYER>
```

Figure 1.5. AXL configuration for one of the Chlorophyll grid layers.

1.4.4 From ArcGIS to ArcIMS

To understand all steps taken to implement the built mapservices in ArcIMS requires some basic knowledge of ArcIMS architecture and operation. For readers not familiar with ArcIMS we refer to the appropriate sections of the ESRI website (e.g. *http://arcscripts.esri.com*) and to the specific ESRI reference guides for building ArcIMS services (among others included on the ArcIMS installation CD's). For customizing ArcIMS html viewer we refer to ArcXML programmer's reference guide (*http://edndoc.esri.com/arcims/9.1/*) and ArcIMS® 4 Architecture and Functionality (ESRI white paper, 2003)

Data

All GIS layers to be displayed in the ArcIMS mapservice are copied automatically to two specified folders on the SPINlab server. One for Shapefiles (vector) and one for Grids (raster):

- Data\WateRs\shape;
- Data\WATeRS.MODIS\Reprojected.

In the following sections we provide a general description, followed by a technical description of the automisation.

Mapservice configuration files (AXL)

These are the AXL (Arc Extensible Markup Language, a specific type of XML) pages that determine which and how the GIS layers are displayed including legends and classifications. The AXL scripts can be written from scratch or can be generated automatically by special extensions (see paragraph above) that convert ArcGIS or ArcView project files to AXL format. Also a ArcExplorer Java edition can be used to save map configurations in AXL format. Take care that the routes to data sources in these files have to be changed manually if they were not produces on the map server itself. To learn more about the AXL format, we refer to the ArcIMS support section of the ESRI website

(*http://support.esri.com*). For more advanced customizations of the AXL files we refer to the ArcXML programmer's reference guide of ESRI.

ArcIMS image services

We decided to use ArcIMS image services (html) and not feature services, as we wanted to make the services as easy accessible possible. The services are made with the ArcIMS administrator on the map server itself. Using a special client program (PuTTY) we could control the ArcIMS services over our network running a remote session on a computer (via SSH, Telnet and Rlogin network protocols). This enables us to stop, restart, remove, add and refresh specific map services remotely from our desktop PC. Adding a new service means implies linking it to an already present AXL in the ArcIMS section of the server. In this case this is WATeRS_Actual.axl located in the ArcIMS\AXL folder. Creating a new service means also choosing a type of image that is used to render the maps. We have chosen png 8 bits images, as these allow map transparency (e.g. jpg images do not allow transparent colours used for the grids with the transcolour tag).

Automation

A directory was created on the SPINlab server (ivm10) Data WATeRS.MODIS. This folder is shared and all rights are given to the Administrators and Marieke Eleveld (operating the WATeRS processing chain).

Tech description

Matlab takes the downloaded file and converts it to a matlab file and a tiff preview image.

Matlab takes the .mat file and writes it into an ESRI Ascii Grid file. The target of this write stream is the /Current folder on SPINLab server (IP 130.37.78.10), writing to here is done using SMB over TCP on port 445 (default).

The PC of the operator retreives a batch file and an AML from SPINLab server using SMB over TCP, and executes it. This batch file invokes arc.exe (ESRI ArcInfo command line) and instructs it to load and execute the AML. The AML contains instructions to reproject each of the files and write the resulting grids to the /Reprojected folder, then evaluate all grids in /Reprojected, and move anything older than 30 days to the archive (except when a file is older than 30 days, but still in use as one of the five most recent files.

PC Operator connects to SPINLab server through SSH2 protocol on port 22 (default), authentication through public-private key pair (1024 bits RSA based key) and executes a batch script on the server.

Batch File 1
reads the contents of the /Reprojected folder and uses command pipes to run this through a chain of unix text tools to create a parameter string containing the five most recent layers. It then calls a second batch file, passing these names as parameters.
Batch File 2

- calls the java-based ESRI ArcIMS administration tool to stop and remove the cur-rent Waters mapservice.
- calls SED on a template AXL document, replacing key values with the parameters prepared in Batch File 1, piped output to a new AXL file.
- clean the server cache.
- calls the java-based ESRI ArcIMS administration tool to add the Waters mapser-vice using the newly written AXL.

Clients connects with Web server on port 80 (Microsoft IIS 5.0)

Software:

- ArcIMS 9.1 running on Apache Tomcat/5.0.28 (ESRI recommended version for compatibility);
- Java runtime -> version not relevant as long as it is fairly recent, we keep ours up to date.

Screenshots

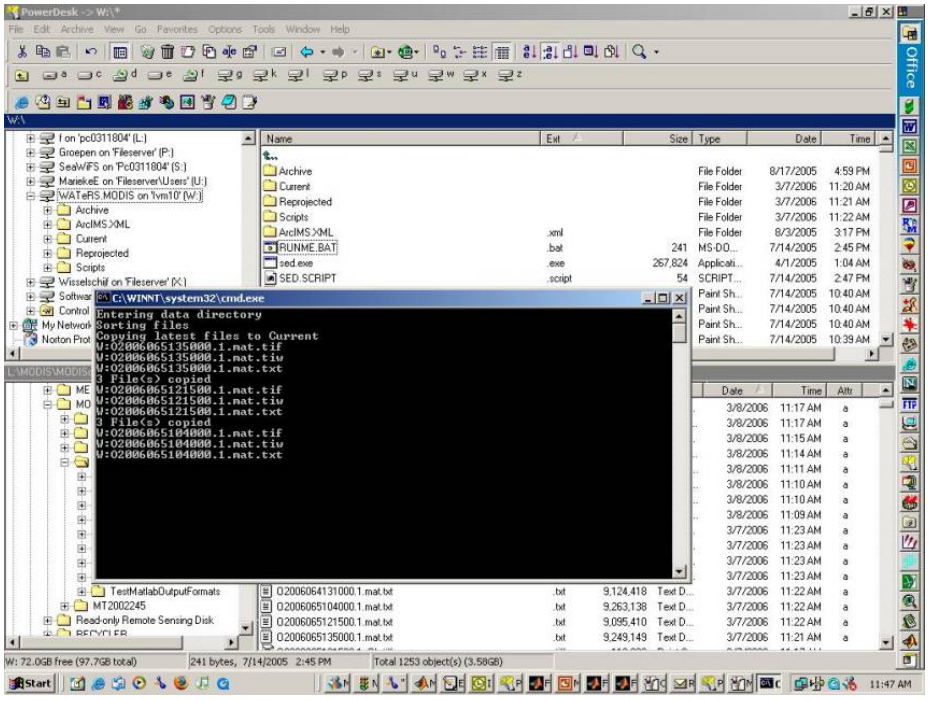


Figure 1.6. Copying latest files to the Current folder on the SPINlab server.

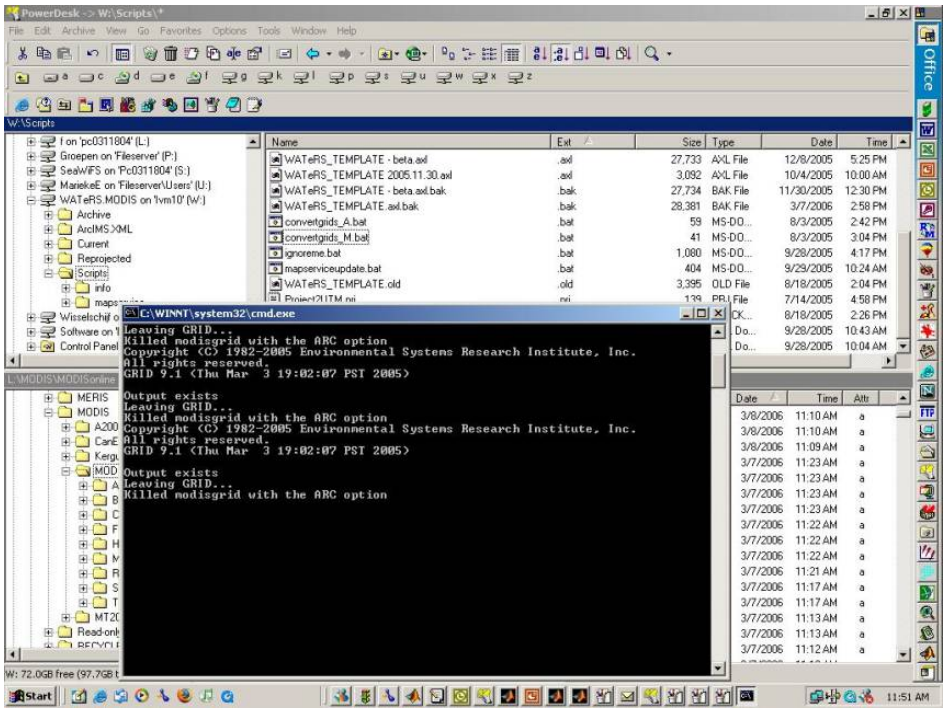


Figure 1.7 Automated reprojection.

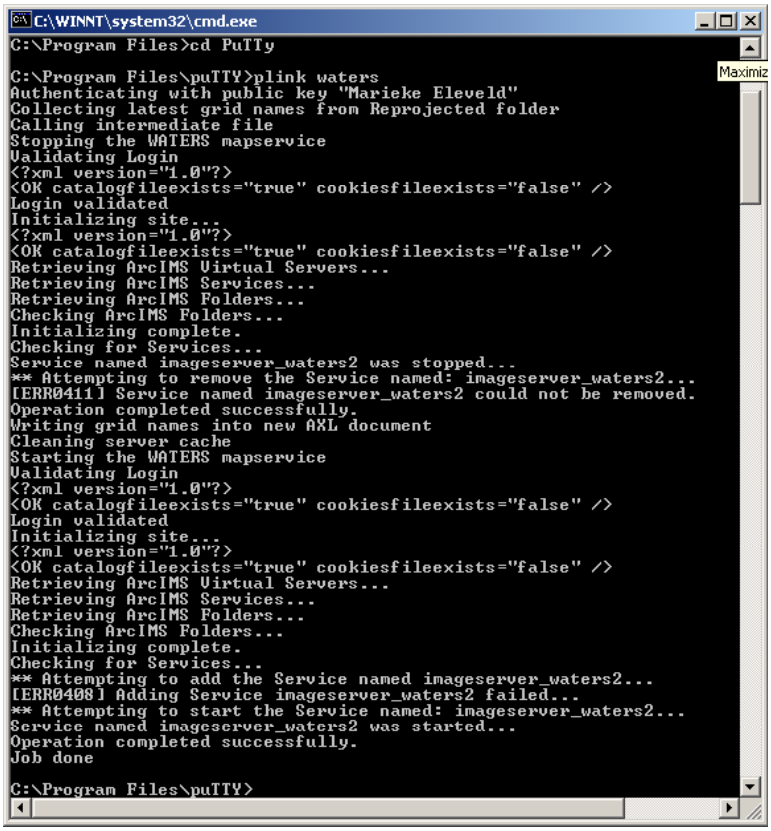


Figure 1.8. Stop, and restart the web server with new files, and maintain the Archive.

1.4.5 Customising ArcIMS HTML Viewer

An important aspect of the work done in this project has been the customization of the standard ArcIMS HTML viewer of ESRI. To see the difference between the default version of the HTML viewer and the customized version. Open subsequently both viewers with your browser:

- *http://ivm10.ivm.vu.nl/mapserver/waters_defaultviewer* (standard viewer)
- *http://ivm10.ivm.vu.nl/mapserver/waters* (customized viewer)

Customization is done by altering the HTML and Javascript files that make up this mapservice. As the HTML Javascript structure of ArcIMS is very complex, we will limit the explanation to some of the major steps and changes we made. For detailed explanation of customization possibilities in the HTML viewer we refer to ESRI's reference guide 'Customizing ArcIMS html viewer'. For some specific changes like changing the loading map and loading data animations when opening a map, panning, zooming etc. instructions can be found in the ESRI support section.

Starting points:

- Fully functional access with normal web browser, optimized for most common browsers (Internet Explorer, Mozilla FireFox and Netscape);
- Create maximum space for map display (ca. 80 % of vertical screen area and ca. 65% of total available screen size);
- Simple and intuitive user interface;
- Divide screen in clear functional areas (see Figure 2.9);
  - Map display area;
  - Navigation / toolbar area;
  - Layers/legend display area;
- Complete and updated metadata for chlorophyll data layers;
- Links to additional data;
- Support section;
- Retrieval of individual grid cell values;
- Optional: possibility for adding layers from external mapservers (multiservice function).

We will discuss the effectuation of the most relevant points here below. Some of the most obvious points like adding links to the additional data will not be discussed here.

Graphical user interface

Changing the graphical look of the map service involves alteration of many html files and the creation and integration of several images that built up the graphical user interface. As this process is more related to website building in general than to building Internet map services. This process includes for example also the modification and changing of the colours of all the icons.

Division in functional areas

An important element has been the resizing and reorganisation of the functional areas as expressed in Figure 2.9 below. Technically speaking most of this work has been done by making changes in a few HTML files (see Box).

Viewer.html:	organizes all the html-framesets that built up the service
Status.htm	dynamic display of coordinate information between navigator area and map display area (this area has been added as not all browser show the coordinate information default in the menubar at the screen bottom) and link to disclaimer. In the default configuration of Arc-IMS, this file is the title.htm file.
Toolbar.htm	controls all toolbar buttons in the navigator area. 2 text buttons were added to provide control over the layer and legend menu
Menu.htm	Second functional layer in the navigator area for extra not standard ArcIMS functionality like spatial bookmarks for monitoring stations (displayed in layers/legend area), link overview to additional data (displayed in layers/legend area), link to waters metadata catalogue, link to help menu (in pop up screen)
Top.htm	Contains the title of the WATeRS project (map title area)
Toc.htm	This frame controls the build up of the layer lists in the layers/legend area and has been altered to make the organisation possible of layers in main groups and individual layers that can be unfolded by group.
Displayframe.htm	This frame displays the (fixed) chlorophyll legend and the link list to additional data.
Locations.htm	Display of spatial bookmarks monitoring stations and fixed chlorophyll legend.

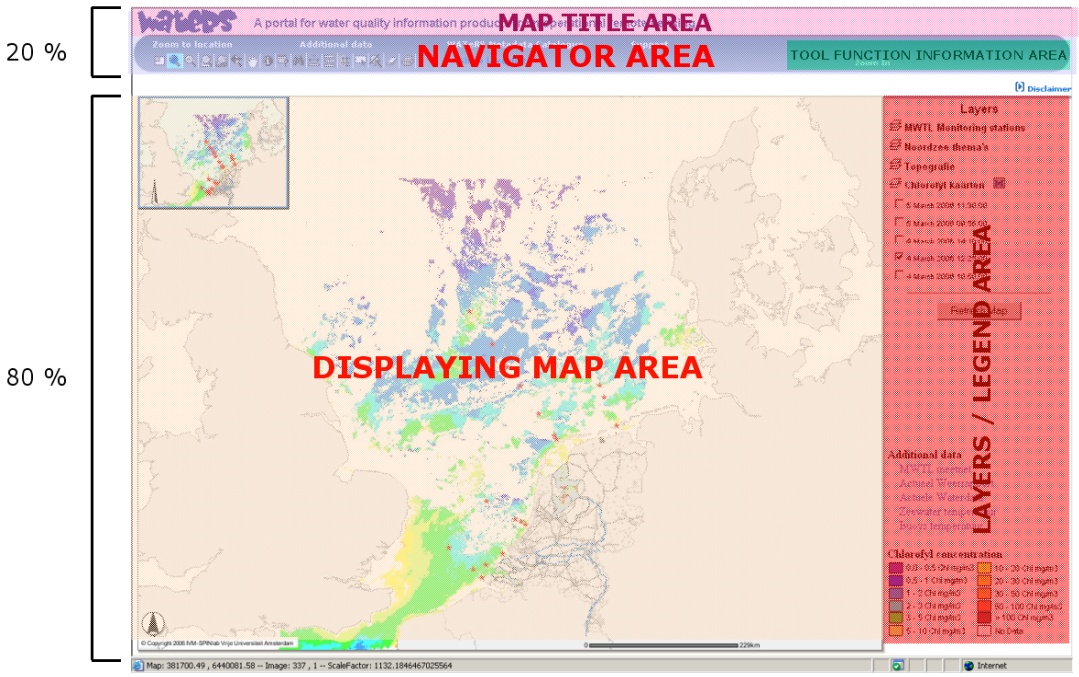
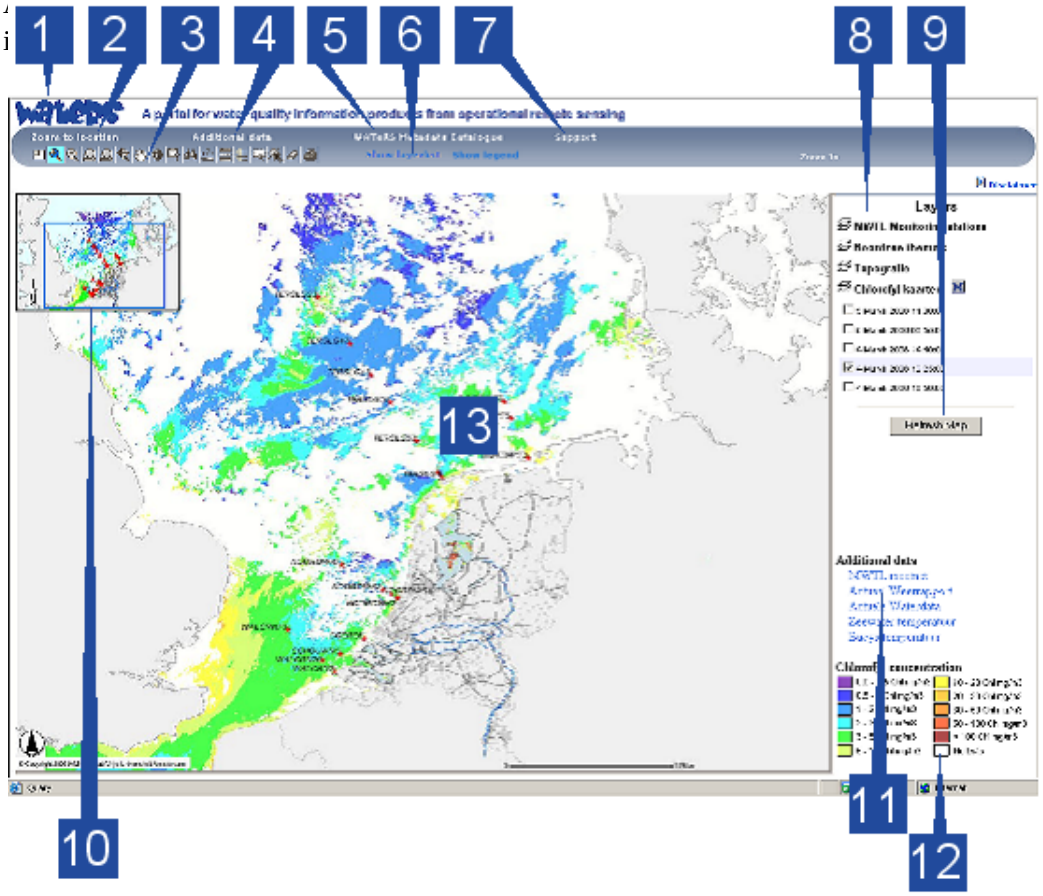


Figure 1.9. Screen division and functional areas of WATeRS mapservice.

Functions and services



Legend Function Groups
1. Map Service title with link to WATeRS website
2. Quick pick list of MWTL monitoring stations for fast access (spatial bookmarks)
3. Toolbox Function Buttons
4. List of additional data (weblinks)
5. WATeRS Metadata Catalogue
6. Bring back layer list and open legend
7. Link to support / help pages
8. Map Layers Display: click on group layers to unfold individual layers!
9. Redraw map button (refresh map)
10. Overview Map
11. Additional data Display (links)
12. Legend Display (Chlorophyll)
13. Map Display

Figure 1.10. Functions and services in the WATeRS mapservice.

Below we give more detail on some of these functions. Several new functions were build using existing ArcIMS building elements in Javascript, for example function number 2 (spatial bookmarks monitoring stations). Some functions are not changed but displayed differently like, the display of legends in a separate popup box (see function group 6). In

this case the display of chlorophyll legends is suppressed as these are already displayed permanently in the right lower corner of the screen. To suppress the legend display of certain layers it is for example necessary to add a variable to the AXL script (showcolourmaplegend) and giving it the value 'false'.

For other functionality like identification of Grid cells with the information button (one of the toolbox function buttons) and the unfold mechanism for the group layers (function group nr. 8) we used already developed extended functionality downloaded from the ESRI script pages on the ESRI support site. For identifying grid cells (RasterIDtools; 4.0.1 Widgets, Jeff Miller, *http://arcscripts.esri.com*).

For layermanagement (grouplayer unfolding) (Grouptoc.zip, Bryan Baker, *http://arcscripts.esri.com*). User instructions work fine for changing the default ArcIMS viewer. This becomes more complicated in a customized version in combination with the grid ID functionality. Also this script doesn't works for Mozilla Firefox. Therefore the script was analysed and rewritten from scratch for implementation in our situation. Alternative scripts found at ESRI scripts for layer group functions are: dbGroup-Toc15a.zip (Dave Bollinger, *http://arcscripts.esri.com*) and dhll-toc.zip (Richard Orth, *http://arcscripts.esri.com*).

1.5 Combination with other datasets for the North Sea

Additional data is available as links. Data from other map services can be combined with a desktop GIS, but also by constructing a Multi-server. Direct combination is only possible with data on a map service in the Dutch coordinate & projection system.

1.5.1 An identified North Sea map service

The Noordzee-atlas contains maps concerning the water system, use, policy and management of the Nederlands Continentaal Plat (NCP) or Nederlandse kustzone. The information can be accessed in three manners:

- Using the Internet site *http://www.noordzeeatlas.nl/* Every map is accompanied by an explanation and meta-information;
- These maps (Map server: *http://roodmapje.aquasense.com*) can be accessed using free ESRI software ArcExplorer Web or ArcExplorer 4.0-Java version, or in our case ArcGIS and ArcIMS software;
- As a book Interdepartementaal Directeurenoverleg Noordzee (IDON), 2004.

1.5.2 Desktop use

In 'Add ArcIMS server' choose *http://130.37.78.10* and select all services.

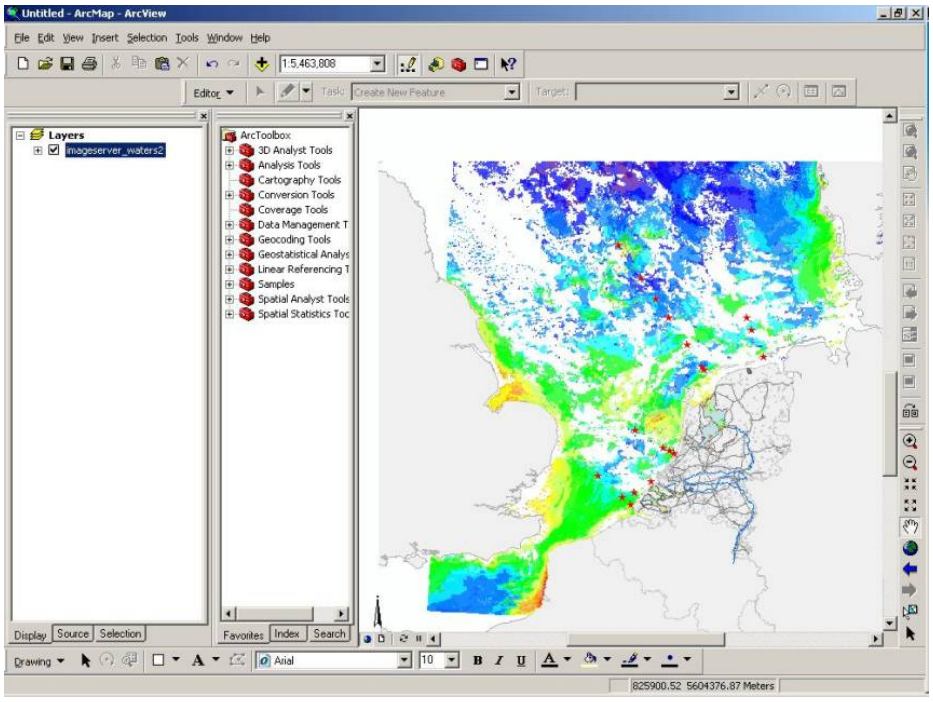


Figure 1.11. Combining with other GIS data: standalone (ArcGIS).

1.5.3 Multi-server

A client can also use *http://ivm10.ivm.vu.nl/mapserver/waters_multiservice/viewer.htm* to combine these services.

Different organisations are specialized in different topics and can provide for example spatial data products in specialized map services. At the same time different organisations can have overlapping interests and use (partly) similar datasets, e.g. background data. Users of for example environmental, meteorological and oceanographic data have often multidisciplinary interests and would like to combine different types of data of a certain geographic area. For these users the possibility of combining mapservices from different sources would be very welcome. Despite the technical possibilities to achieve such multiservices, few operational multiservices have been developed so far. This is not the place, nor the time to discuss the reasons behind these slow developments in this field, but it is relevant to find out how easy it is, to develop such a service using the standard, interoperable, web mapping software of ESRI. Therefore we have investigated the application of the ArcIMS Multi-Service Viewer, which is one of the sample ArcIMS HTML viewers provided by ESRI. With this viewer multiple ArcIMS image map services from multiple servers supports can be combined simultaneously, resulting in the rendering of a composite map.

The first difficulty of implementing the multi-service viewer is finding useful working instructions. ESRI doesn't provide any kind of working manuals or reference guide for setting up this service, except some basic instructions that come with the sample viewer (browse to the html viewer in the mapservices overview and select multi-service setup). Also on the ESRI support pages or in general on the web, few information can be found

concerning this matter. The few information which can be found is not very promising, like the remarks of Pieper & Deneau (2005) who state that the 'Multi-Service Viewer is a good starting point for implementing this type of de-centralized ArcIMS deployment strategy. However, it is somewhat un-refined and cumbersome to work with.' They add that to 'overcome the "out of the box" limitations', they had to substantially modify and enhance the provided sample code.

Our technical experiences with the setup of the multi-service viewer for combining our own mapservices with external services are the following.

As it turns out, the ESRI html/javascript based viewer handles the multiservice option as a heavily customized variant on the standard, which is single-service. This leads to it being extraordinary complicated to turn an already customized existing mapservice viewer, as exists for WATERS, into a viewer capable of displaying multiple image services layered on top of each other. This situation is exacerbated by the complete absence of documentation on the part of ESRI that might reveal exactly which modifications were made to their standard to get to the multiservice-modified version.

We have so far been unsuccessful at introducing multiservice functionality into the WATERS mapservice. For future projects, an alternative to the standard ESRI html viewer may be in order which is designed the other way around, making multiservice functionality the standard and a single-service mapservice an instance of a multiservice where the number of services is one.

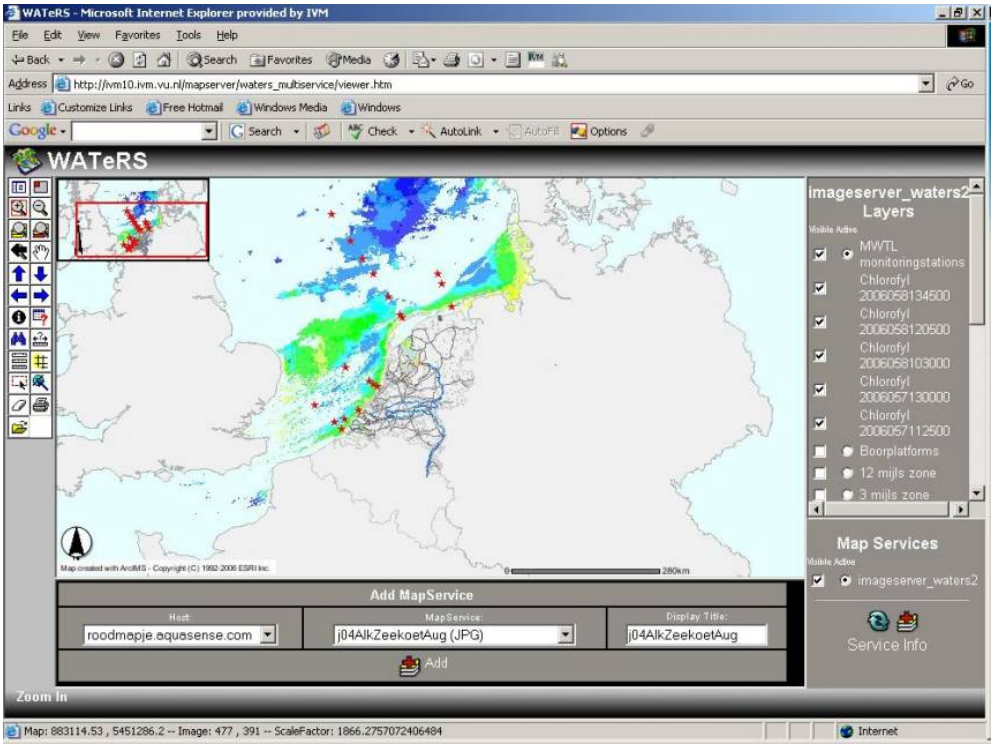


Figure 1.12. Combining with other GIS data: or web services (ArcIMS).

1.6 4. WATeRS Metadata Catalogue

The main purpose of the metadata catalogue is to provide users of the water quality portal with information regarding the assessment of meaning and value of data-sets. As the main derived product displayed in the WATeRS mapservice are the Chlorophyll maps and we are not the producers nor owners of the displayed background maps we have chosen to only provide metadata for the Chlorophyll layers.

Some characteristics of the metadata catalogue are:

- Conformation to the minimum set of mandatory metadata elements, CEN ENV 12657;
- Understandable metadata elements: no codification but textual descriptions of map characteristics;
- Flexible, but limited Interoperability (simple Access database, but no direct exchange with other metadata catalogues or tools possible);
- Updateable anytime, anywhere (via the Internet).

The metadata catalogue is available for viewing for all users and for editing via the web by registered users of the project (the metadata administrator). The metadata catalogue is divided in 3 main sections (see Figure 2.13).

On the left hand side, a window with a list of general project information and the spatial datasets concerning water quality (in this showcase only the chlorophyll layers). In the right window the actual metadata of the selected spatial dataset is displayed. Further a pop-up window with a snapshot image -if available- of the data is automatically displayed. Colours indicate if metadata is mandatory or optional and the information window on the left below gives additional information on the metadata elements if the cursor is moved over the text of the metadata element.

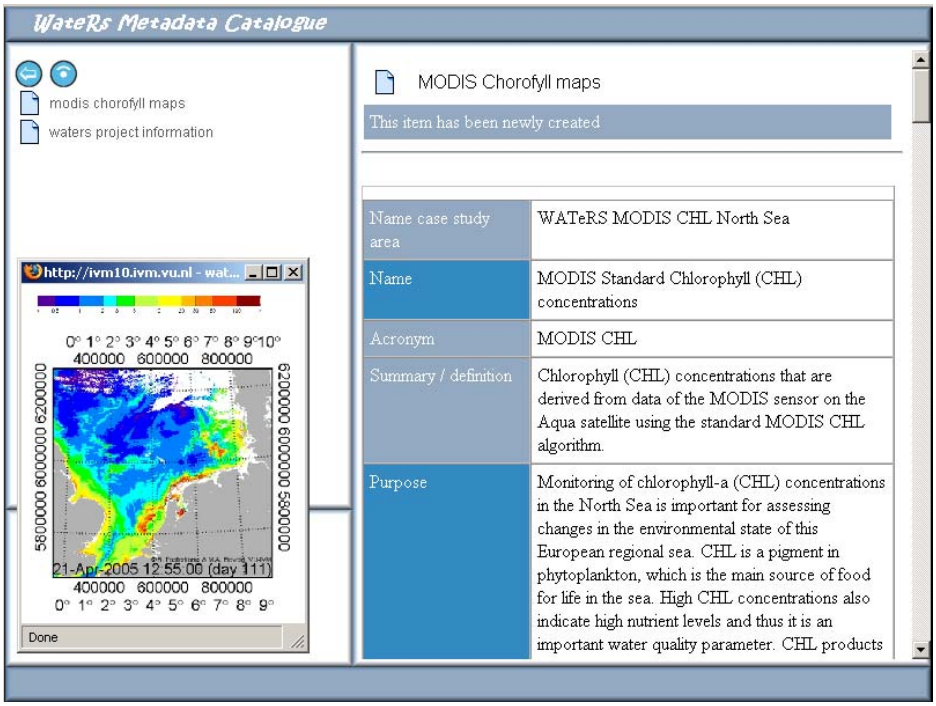


Figure 1.13. User interface of the metadata catalogue.

The mandatory and optional metadata elements especially selected for the WATeRS project are in accordance with the European standard for spatial metadata (CEN ENV 12657). The metadata catalogue is linked directly to the corresponding mapservice. The metadata catalogue was built using common Internet technology like ASP (Active Service Pages) linked to a ODBC compliant database (MS Access). The online metadata catalogue service will be maintained by the IVM-VUA SPINlab as long as the catalogue and the map services are used by either the participating research teams of the Vrije Universiteit or by external users.

1.7 Conclusions

We developed a generic method to convert satellite data (in scientific formats) to information in GIS formats. We serve this information, near-real time and interactively available for all on the Internet via a customised web service. The main result from a user point of view is this information service. On the long term this service will encourage WQ managers to use RS (products) for their monitoring purposes. The main result from a technical point of view is the WATeRS portal itself: *http://ivm10.ivm.vu.nl/mapserver/waters/* an innovative customised ArcIMS-application with a WMS ArcIMS-OGC connector, developed at VU-IVM in a collaboration of Remote Sensing and SPINlab scientists.

Our results will be presented at the 2006 ICES Annual Science Conference is in the pipeline (Eleveld et al., 2006). Geodan & Water Insight will also make some publicity for WATeRS. We are also aiming at extracting some scientific articles out of this work. In addition, WATeRS has been mentioned on:

- ArcIMS NewsSites;
- IOCCG News and EoPortal;
-
- Natuur, wetenschap en Techniek and Noorderlicht VPRO (Internet);
-
- VU news & AdValvas and IVM news.
-

Other Presentations & Demonstration were made for:

- Light & Water;
- IVM SPACE and IVM Thematic Clusters SPACEToCo & CRESCIO;
- Highschool students (Leerlingen VWO Liemers College, locatie Heerenmaten Zevenaar).

Counters on WATeRS provided the following web statistics : we have about 5 hits / day since May 2006, with an average of 2 hits per visitor. 87 % of the visitors use a Dutch account, 10 % unknown, other (mainly North Sea bordering countries Belgium, Norway, Germany, France, Italy, Great-Brittan).

The developed and implemented services currently show only part of the application potential of both the remote sensing data, and the processing architecture behind this portal. Because of the limited scope of the project, more elaborate services such as those giving access to and analytical usage of WATeRS it’s database with historical data are not yet fully exploited.

The next two parts of this report were written by two external partners Geodan & Water Insight that have been working on Testing and evaluation, and Costs of exploitation and continuity of the service

References

Eleveld, M.A., Wagtendonk, A.J., Pasterkamp, R, de Reus, N.O. & van der Woerd, H.J. (2006). *WATeRS: A Web Map Service with near-real time MODIS standard chlorophyll products of the North Sea*. ICES CM 2006 M, 19/23-09-2006 in Maastricht. www.ices.dk/asc2006/.

Eleveld, M.A. & van der Woerd, H.J. (2006). Patterns in water quality products of the North Sea: variogram analyses of single and compound SeaWiFS CHL & SPM grids. In: Kerle, N. & Skidmore, A.K. (eds). *Remote Sensing: From Pixels To Processes*. ISPRS Proceedings Technical Commission VII. Publisher: ITC, Enschede (The Netherlands).

Eleveld, M.A., van der Woerd, H.J., Omtzigt, N. & Jørgensen, P.V. (2004). Monitoring the North Sea with MERIS: Chlorophyll-a and associated Value Added Products. In: Green et al. (eds.), (2004). *Littoral 2004. Delivering sustainable coasts: Connecting science and policy*. Cambridge Publications, Cambridge, Vol. 2, pp. 456-460. (Proceedings LITTORAL 2004. Seventh international symposium Delivering sustainable coasts: Connecting science and policy, 20th-22nd September 2004, Aberdeen, Scotland (UK)).

ESRI (2006). *ArcGIS, ArcView & ArcIMS documentation*, http://www.esri.com/.

Esaias, E., Abbott, M., Barton, I., Brown, O.B., Campbell, J.W., Carder, K.L., Clark, D.K., Evans, R.H., Hoge, F.E., Gordon, H.R., Balch, W.M., Letelier, R. & Minnett, P.J. (1998). An overview of MODIS capabilities for ocean science observations. IEEE Trans. *Geosci. Remote Sensing, 36*(4), 1250–1265.

IDON (Interdepartmentaal Directeuren Overleg Noordzee) (2004). *Noordzee-atlas*. Ministerie van Verkeer en Waterstaat / Rijkswaterstaat directie Noordzee, Rijswijk. (on-line available at http://www.noordzeeatlas.nl).

MathWorks (2006). *Matlab documentation* www.mathworks.com.

Pieper, F. & Deneau, D. (2005). *Taming the ArcIMS Multi-Service Viewer*, ESRI professional paper, North East Arc Users group conference; Institute for the Application of Geospatial Technology.

Van der Woerd, H.J., Blauw, A., Pasterkamp, R., Tatman, S., Laanen, M., Peperzak, L. (2005). I*ntegrated spatial and spectral characterisation of harmful algal blooms in Dutch coastal waters (ISCHA): Demonstration of a HAB service in the Zeeuwsche Voordelta*. IVM Report R-05/09, Instituut voor Milieuvraagstukken (VU-IVM), Amsterdam.

2. Test Report WATeRS

Scepec, S. & Bonn, B.

A report of activities for WP5 Testing and evaluation

For more information please contact betty.bonn@geodan.nl

2.2 Introduction

Geodan IT performed tests on functionality and user friendliness of the WATeRS portal. The main purpose of this test report is to provide IVM with issues on how to improve the WATeRS portal. The results are described in the following paragraphs.

2.3 Summary of test results

2.3.1 User interface

In general the site is quite user friendly. The user is not chased with pop-ups, but gets the information needed;

The design of the site is very attractive. The display of the functional screen is simple and clear, letting the user concentrate on the map display;

The user interface is very intuitive, except for the query builder. The presentation of sample values is helpful;

The links to additional data are interesting.

2.3.2 Map

The map tools work fine, fast and correctly. Panning is quite slow, but delivers the correct results;

The retrieval of individual grid cell values of Chlorophyll layers works fast and delivers correct values (compared to the colour code);

The overview map is quite small; making it difficult to specify which region is being displayed. The user can only specify a point to zoom in to and not an area;

Maximum and minimum extents are not specified. The user is able to zoom out beyond any means. To improve performance at this zoom level the user should be given information about the maximum extent being reached instead of retrieving a map.

2.3.3 Print

The output of the print functionality is attractive.

2.3.4 Help

The help section is nicely designed, informative, and truly helpful. It works intuitively. If for instance the user tries to get information about an active but invisible layer, he/she gets an informative warning enabling him/her to solve this problem.

2.3.5 Browsers

The site is fully accessible with all common web browsers (IE, Netscape, FireFox), for more specific information; please see chapters 3 and 4.

2.3.6 OpenGIS compliancy

ArcIMS' WMS connector has been installed, enabling the WATeRS portal to be Open-GIS compliant. All WATeRS data can be accessed using desktop mapping software. For viewing WATeRS data in MapInfo Professional 8.0, see Figures 2.14 and 2.15.

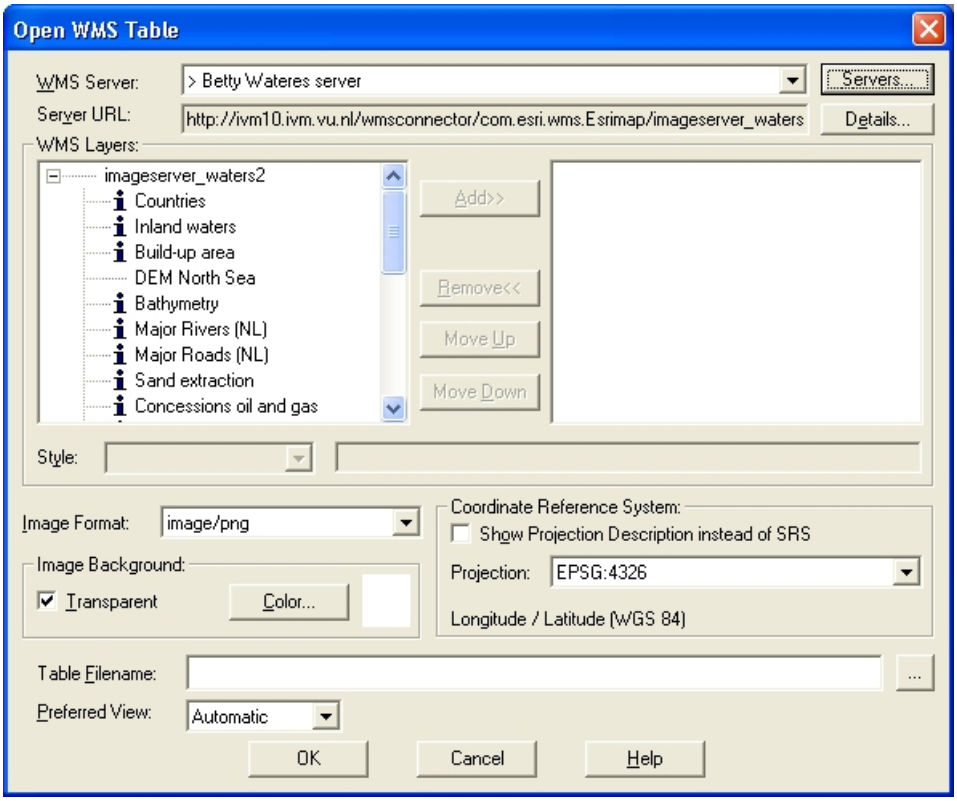


Figure 2.1. Accessing WATeRS using the WMS connector.

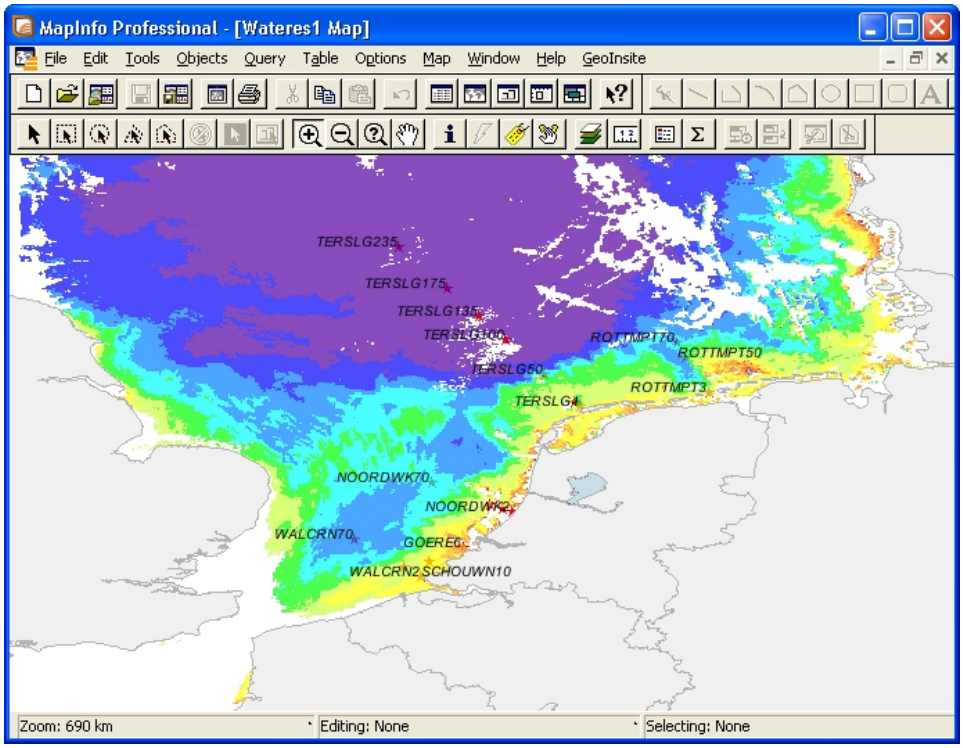


Figure 2.2. View in WATeRS data using desktop GIS software.

2.4 Test Results Internet Explorer 6.0.2900.2180.xpsp_sp2_gdr.050301-1519

In the narrow column on the right the following code is used:

- \+ for good performance and/of design;
- p consider a problem;
- ? when impact can not be judged;
- u used design or functionality to improve;
- h should be addressed in Help section.

Function	Comment	
Start site	*http://ivm10.ivm.vu.nl/mapserver/WATeRS/viewer.htm*: Error message: Unable to start. Message: Required HTML Form missing (jsForm.htm). "Retrieving data" continues. Problem can be solved by removing "/viewer.htm" from the URL.	p
Tooltips	Work fine	+
Overview Map	Toggle overview map	+
	Blue box moves after mouse click. (There could be an info in the help and/or tooltip that is does not work with dragging the blue box)	+
	Blue box changes format after clicking next to maximum extent. Box keeps changed format even when clicking in the middle of the map afterwards (at least sometimes).	u
Zoom In	Zoom in after mouse click	+
	Zoom in after dragging a box	+

Function	Comment	
Zoom Out	Works fine	+
	What about “maximum extent reached” instead of “Retrieving map”?	u
Zoom to Full Extent	Works fine	+
Zoom to Active Layer	Works fine	+
Back to last extent	Works fine	+
Pan	After zooming in, panning works correctly.	+
	What about different cursor types? A hand when panning is active, for instance?	u
	During mouse drag the map is panned. On mouse release the former extent shows up again for a short time.	u
	At or near full extent, panning is not possible. Please consider a warning “maximum extent reached”.	u
Identify	Trying to get information about an active layer which is not visible results in an informative warning.	+
	Retrieval of individual grid cell values works correctly.	+
Query	Not very intuitive	u
	More instructions needed	u
	Operator is set to “>”, get Samples for values is used, Operator is set back to “=”.	p
	It is a good idea to present sample values	+
	After the query being executed, it is not possible to start a new query without closing and opening the query frame again. So the query can not be specified any further.	u
	Zoom to records works fine	+
	Zoom to one record works fine	+
Find	After pressing the button, the find frame appears in the background.	u
	Find function works correctly.	+
	Help: How to select layers you would like to search? Searching works on the active layer. Only one layer can be active.	?
Measure	Works correctly.	+
	Nothing found in help about using button “clear selected features” to get rid of the measured lines on the map.	h
Buffer	Works excellently	+
Set Units	Works fine, even already presented values are recalculated.	+
Select by Rectangle	Works very fast	+
	Using select by Rectangle with an active invisible layer results in an instructive warning.	+
Select by line/polygon	During defining the line by clicking on the map, the “select by line/polygon” frame disappears in the background. Resizing the window now leads to retrieving the map with full extent. The user has to start over again.	p
	When defining a polygon with crossed lines, instead of an error message the result is: no features are found. Perhaps not understandable for a user?	u
	“Delete last point” works fine	+
	“Select” works fine	+
	“Restart” works fine	+

Function	Comment	
Clear Selected Features	Works fine	+
Print	Works fine	+
Show legend	Works fine	+
Zoom to location	Works fine	+
Metadata catalog	Works fine	+
Layers	Unfolding files	+
	Activating checkboxes to set layers visible	+
(on the right)	Refreshing map with different combinations of layers visible	+
	Setting a layer active	+
	The layer “DEM North sea” has a wide white border. As it lies on top of layer “countries”, layer “countries cannot be viewed.	u
Additional data / links	Works fine	+

2.5 Additional Test Results Firefox 1.5.0.3

In the narrow column on the right the following code is used:

- + for good performance and/of design;
- p consider a problem;
- ? when impact can not be judged;
- u used design or functionality to improve;
- h should be addressed in Help section.

Function	Comment	
Tooltips	Tooltips do not work. (If they are set with “ALT”, they only work with IExplorer. For FireFox, they have to be set using “TITLE”)	p
Overview map	Works better than with IE	+
Identify	Presentation of individual grid cell values: Value is not rewritten, but a new text field is added.	?
Layers	Unfolding files: Files are folded again after “refreshing map” to set layers visible	u
(on the right)	Setting a layer active: active layer is not presented in blue any more after “ refreshing map”	u
Pop-up windows	When starting with popup windows blocked, the information box from FireFox is shown too shortly to be read.	u

2.6 Recommendations

2.6.1 User interface

- The overview map could be displayed a little larger. Is it possible to let a user drag a box to specify an area to zoom in to?
- Help on how to use the query builder may be improved. Grid layers cannot be queried using the query builder, though the user is able to get the grid values. It may be an idea to create a pop-up message displaying: “Grid layers can not be queried” and instructions on how to get the grid (Chlorophyll) values;
- Enable the user to specify a query further, by letting him/her re-use the query builder without closing and opening first;

- Specify maximum and minimum extent, enabling the user to note when minimum or maximum extent is reached. Please consider a warning “maximum (minimum) extent reached”;
- Add information about the button “clear selected features” to the help section;
- Improve error message “no features are found” when defining a polygon with crossed lines. Fort example: “The drawn feature consist of more than one polygon”;
- Change default order of layers “DEM North Sea” and “countries”. Layer “countries” should be on top of “DEM North Sea”.

2.6.2 Firefox

Improve functionality of tooltips.

3. Marketing Research WATeRS Portal

Laanen, M. & Bonn, B.

A report of activities for WP 6 Costs of exploitation and continuity of the service

For more information please contact laanen@waterinsight.nl or betty.bonn@geodan.nl

3.2 Introduction

WATeRS is a portal for water quality information products derived from operational remote sensing. Its URL is *http://ivm10.ivm.vu.nl/mapserver/waters.*

The objective of the WATERS project is not merely to initiate the WATeRS Portal, but also to firmly position it within the water quality community (see WATeRS project proposal). In order to complete this objective, the continuation of the WATeRS Portal after the WATERS project has to be ensured. Means and resources therefore have to be located outside the current WATeRS project.

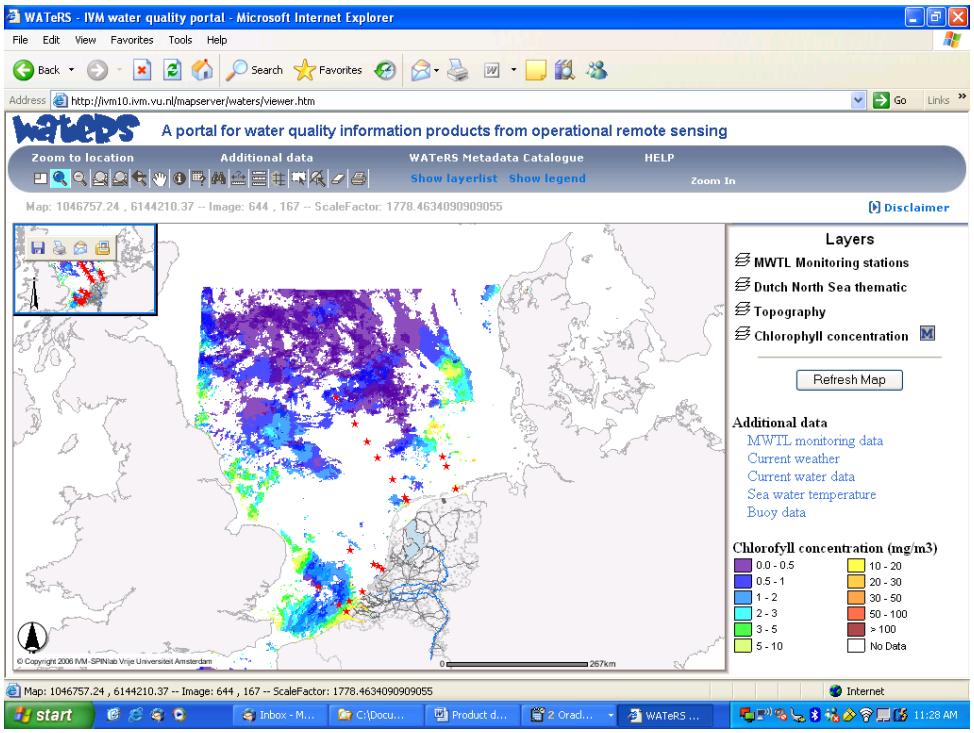


Figure 3.1. WATeRS Portal.

In this chapter the results are discussed of a qualitative marketing research that has been conducted. The goal of this marketing research is to explore the possibilities for continuation of the WATeRS Portal as a paid or sponsored service. The main constraint here is that the WATeRS Portal should be operated at least budget neutral.

Within the WATeRS Portal marketing research the following analyses are performed to achieve the goal stated above:

- Service analysis, defining the offered WATeRS Portal and the costs analyses;
- Market analysis, identifying potential clients or sponsors and estimation of the market size;
- Competitor analysis, identifying possible competitors and comparing their products and services to the WATeRS Portal;
- Analysis of possible business models.

Based on the results of these analyses (some are left out of this report because of its confidential nature) a number of conclusions are drawn (which are in this report) and a number of recommendations are given.

The research was partly funded by the National User Support Programme (NUSP) 2001-2005 *http://www.ao-go.nivr.nl*.

3.3 Service Analysis

WATeRS Portal is a web portal where water quality information in the form of chlorophyll concentration maps is shown, together with some ancillary data such as in situ measurements and geographical reference information such as e.g. shorelines. These chlorophyll maps are derived from MODIS satellite imagery by NASA itself (MODIS standard level-2 chlorophyll products from NASA). The focus in this chapter lies on WATeRS as a service. However there are more products to consider for marketing. These derived product are mentioned in paragraph 3.2.4.

For brevity, the content of the WATeRS data will not be described further here as it is already discussed at length in chapter 9. The key discerning features of WATeRS Portal, listed below, will however be elaborated on in this chapter:

- Geographical water quality data;
- Update speed;
- Ease of use.

3.3.1 Geographical water quality data

The WATeRS Portal offers interactive GIS analysis possibilities. The WATeRS Portal is the first free and regularly updated service providing North Sea chlorophyll-a maps combined with other geographical data. Pictures of chlorophyll maps are readily available on the Internet, but analysis or comparison based on these is quite cumbersome.

3.3.2 Update Speed

Most web mapping server applications have fixed data contents or are only updated at very long intervals. As a consequence of adding new data a web mapping server, such as the ArcIMS server used for WATeRS Portal, needs to be restarted in order to make the new data visible and accessible. Using a series of specially developed scripts the WATeRS Portal can be updated semi-automatically in mere minutes.

In this way, the latest MODIS chlorophyll maps from NASA are made available through the WATeRS Portal 4-5 times a week. Theoretically it would be possible to show all MODIS chlorophyll maps for the area just hours after it has been made available by NASA.

3.3.3 Ease of use

Care has been taken with the WATeRS Portal to develop a user friendly and intuitive user interface, while displaying the geographical data in the largest possible area. In contrast to many other web mapping applications, WATeRS Portal can be queried just as easy by experts and novice users.

3.3.4 Other products having market potential

Several other products can be derived from the WATeRS Water Quality Portal. The ones that may have market potential are:

- Technology (a transferable version of the portal will be quite difficult, but consulting about how to set up a comparable portal may be a sellable 'product');
- Other water quality data (other than chlorophyll);
- Other data (on land, in the atmosphere);
- Comparisons and aggregations of above mentioned data, i.e. ArcGIS GRIDS as of June 2005 almost daily;
- Geographical extension (world).

3.4 Cost Analysis

An overview of the current annual operational costs, which will be equal to the costs of running the WATeRS Portal as a sponsored service, is as follows. The use of MODIS imagery is free of charge at present; NASA expects this policy to continue in the near future (*http://daac.gsfc.nasa.gov/MODIS/FAQ /A_data_cost.shtml*). Some funds are required for licences and costs of operation. Please note that the costs for data traffic are not included, because it is assumed that this is negligible with respect to the total data traffic of the institute. In order to continue the WATeRS Portal service at the IVM a yearly sponsorship of at least 25 k€ is thus required.

The licenses of the software used presently for the WATeRS Portal are restricted to scientific and educational use. When the WATeRS Portal is offered as a paid service, commercial licenses will be required. The commercial use of MODIS imagery however is allowed free of charge. The total costs for commercial software licenses, without maintenance contracts, to continue the WATeRS Portal service at the IVM on a break even basis, would require a yearly revenue of at least 38 k€.

3.5 SWOT analysis

The acronym "SWOT" stands for Strengths, Weaknesses, Opportunities and Threats. This simple tool is often used in the strategic planning phase when releasing a new product onto the market. By building on strengths, reversing weaknesses, maximizing opportunities and overcoming threats related to the product, the marketing strategy can be de-

termined and optimized. Strengths and weaknesses are usually considerations within the market while opportunities and threats are considerations with more external influence.

The SWOT analysis has been based on expert knowledge of the WATeRS team members. The Strengths and Weaknesses are factors that are related to the technical issues of the WATeRS Portal service, whereas the Opportunities and Threats are external factors, related to competitors and clients.

Strengths	Weaknesses
➔ Near real-time, update speed almost daily ➔ Easy to use ➔ The possibility of using the data in a desktop GIS-environment of any organization ➔ No direct competition ➔ Can be used for PR purposes ➔ Real data, no pictures ➔ Can be easily extended with other data (sea surface temperatures, total suspended matter, transparency) ➔ Can easily be extended to a larger area (the entire world) ➔ Satellite data available in any regular GIS format ➔ Chlorophyll concentration is an indicator for eutrophication problems. Together with the transparency, which is also available as a satellite product, basic aquatic ecosystem health can be determined Scripts are generic and usable for fast automated data conversion	➔ Current WATeRS Portal requires too much manual operation ➔ The WATeRS Portal service is very dependent on the availability and workload of certain employees ➔ Pricing of commercial web server licenses ➔ MERIS data is better than MODIS data (however MERIS data only covers Europe and will stop being distributed in 2007) ➔ The IVM algorithm is better than the standard MODIS algorithm ➔ Service not stable enough for 98 % uptime guarantee ➔ Technology is complex and therefore not easily transferable ➔ Customized client
Opportunities	**Threats**
➔ Current information need of water managers ➔ Growing interest in water quality ➔ Rijkswaterstaat cannot afford to continue its current monitoring system ➔ The implementation of the Euro-pean Water Framework Directive, will lead to an increase the information need	➔ Other water quality information services ➔ Affordable pricing of WATeRS Portal service ➔ Funding is hard to get from large governmental organizations

The main weakness of the current WATeRS Portal service is the large amount of labour required to manually operate the scripting for updates.

3.6 Business models

Three different business models can be discerned for operating the WATeRS Portal beyond the WATeRS project:

- Sponsored WATeRS Portal service operated by IVM;
- Paid WATeRS Portal service operated by IVM;
- Paid WATeRS Portal service operated by a commercial party.

3.6.1 Sponsored WATeRS Portal service operated by IVM

In this case the WATeRS Portal is more or less continued as is, offering the North Sea water quality information free of charge to the general public. There are a number of advantages and disadvantages to this business model, which are given below:

Advantages

- By offering a free information service, the IVM uses the WATeRS Portal as a public relations tool. IVM knowledge and skills are demonstrated to potential IVM clients, potential IVM research partners and to the general public;
- Because the service is not commercial, existing educational and scientific software licenses can be used.

Disadvantages

- In this case the bulk of the resources required to operate the WATeRS Portal will have to come from IVM itself, while at best some additional sponsor or subsidiary money will be provided by e.g. governemental bodies such as Rijkswaterstaat or by interest groups such as the ANWB because it is a public service;
- Regular updating of the WATeRS Portal is insecure as it is highly dependent on the availability and workload of certain IVM employees;
- The sponsorship model will be highly insecure with regard to WATeRS Portal continuity because it is likely to be scrapped in times of economic crisis.

Continuing the current free of charge WATeRS Portal portal, for instance as a public relations instrument for IVM, can be easily done in combination with a paid WATeRS Portal service providing additional functionality, as the extra costs of the free service are negligible compared to the costs of a paid service. In the following 2 commercial models the current free WATeRS Portal can therefore be continued alongside paid services.

3.6.2 Paid WATeRS Portal service operated by IVM

Advantages

- The WATeRS Portal can operate self-supporting, generating its own resources for continuation.

Disadvantages

- Because the service is commercial, the operating costs increase significantly (about doubled, see costs section) as commercial software licenses are required;
- Offering a lasting paid information service does not fit the IVM core business as a research institute, where the emphasis is on scientific research and mid- to long-term projects. Practical considerations with respect to availability and workload of certain IVM employees, where updating the WATeRS Portal has no priority.

3.6.3 Paid WATeRS Portal service operated by a commercial party

Advantages

- The WATeRS Portal can operate self-supporting, generating its own resources for continuation;
- A lasting paid information service better fits the core business of a commercial party, where the emphasis is on daily delivery of the offered products. Update of WATeRS Portal does have priority.

Disadvantages

- Because the service is commercial, the operating costs increase significantly (about doubled, see costs section) as commercial software licenses are required.

3.6.4 Test GeoServer

The WATeRS project consortium proposes to organize a three-month test bed of the service operated by a commercial party, in order to:

- Research if current and potential IVM clients are interested;
- Get experience with this type of service;
- Gather information about expected amount of hits.

Geodan IT is willing to distribute the data through their GeoServer data service (for more information, please check *http://www.geoserver.nl*). Organizations can now try the WATeRS data in their own GIS environments without costs. If successful, either Geodan IT or any other interested party may negotiate with IVM to continue the service.

ESRI Netherlands is willing to cooperate; they allow IVM to distribute their data through a commercial data service during the three month test bed without increasing the costs of the ArcIMS license.

NASA poses no restrictions on this redistribution their data.

The test bed will run in September, October and November 2006, giving the organizations involved enough time to prepare the promotional activities.

3.7 Conclusions and recommendations

In the present form of the WATeRS Portal the largest cost factor (about 70% of total costs) is the manual operation of scripts required to update the service. It is strongly advised to automate the running of these scripts, reducing the amount of labour hours. This may lead to a 60% cost reduction of the WATeRS Portal.

One of the main conclusions of this chapter is that the WATeRS Portal cannot continue in the current form, which is a purely sponsored service. The most obvious sponsor, the IVM itself, has no intention to allocate resources for continuation of the portal as is. Furthermore, a sponsored WATeRS Portal is very dependent on the availability and workload of certain IVM employees.

The WATeRS Portal should thus be changed in to a paid service in order to ensure continuation. Two forms of paid WATeRS Portal services are identified: a paid service operated by the IVM and one operated by a third party, a commercial company.

There are several commercial parties that may be interested to implement the technology built for WATeRS, to distribute the data, and to maintain the service. However they need clients (“prospects”) to pay for this service.

The most important prospect is Rijkswaterstaat. Before Rijkswaterstaat is actually willing to use the service, a number of enhancements should be made to the WATeRS Portal.

These are:

- Export to client data environment (the CALAMARIS environment of RWS). Although the WATeRS Portal is already based on OpenGIS standards, some minor adjustments are expected;
- Other instrument data, such as MERIS satellite images;
- Other parameters, such as total suspended matter and transparency;
- Other algorithms, such as the REVAMP North Sea algorithm developed by IVM.

Other prospects include research institutes such as WL | Delft Hydraulics, who will want to use the data provided by the WATeRS Portal as input for their models. The willingness to pay for a WATeRS Portal service by other prospects such as interest groups, dredging companies and fishermen is likely to be low in the near future.

The main advantage of the direction chosen (a three month test bed) is that all organisations involved (IVM, Geodan IT, Water Insight, potential clients) can use and view the WATeRS data for free during three months. The findings of this test bed will be evaluated and will result in a new plan.

3.8 Product description

A brief description of the data (derived from the metadata on the WATeRS web site) follows:

3.8.1 Content

Chlorophyll (CHL) concentrations (Chlorophyll-a in mg/m3) that are derived from data of the MODIS sensor on the Aqua satellite using the standard MODIS CHL algorithm. CHL is a pigment in phytoplankton, which is the main source of food for life in the sea. High CHL concentrations also indicate high nutrient levels and thus it is an important water quality parameter. CHL products derived from satellite data become increasingly available for practitioners and stakeholders with an interest in the coastal environment.

3.8.2 Lineage

Chlorophyll (CHL) concentrations that are derived from data of the MODIS sensor on the Aqua satellite using the standard MODIS CHL algorithm. Standard MODIS Level-2 chlorophyll (CHL) products originate from a Level-2 data Near-Real Time Image Support subscription *http://oceancolor.gsfc.nasa.gov/*.Reference: Feldman, G. C., C. R. McClain; *http://oceancolor.gsfc.nasa.gov/*, Ocean Color Web, MODIS Aqua Reprocessing:, *http://oceancolor.gsfc.nasa.gov/ REPROCESSING/; http://oceancolor.gsfc.nasa.gov/ DOCS/MSL12/MSl12*.Changes NASA Goddard Space Flight Center. Eds. Kuring, N., Bailey, S. W.1 Jan 2005 – present; *http://oceancolor.gsfc.nasa.gov/*.

MODIS imagery is based on data that were acquired as part of the NASA's Earth Science Enterprise. The algorithms were developed by the MODIS Science Teams and processed to Level-2 data within the Ocean Data Processing System (ODPS). Using software, developed by IVM, these products were extracted, geo-rectified, images acquired within a time interval of less than 10 minutes were stitched and visualised. Subse-

quently, the files were exported in customized GIS formats, as ESRI ASCII grid formats and geo-tiffs..The ESRI ASCI grids were converted to true GISraster (ESRI gridformat) in ArcGIS. Finally, The layers are automatically collected from the Reprojected folder, the WATeRS mapservice is stopped and restarted with the new layers.

3.8.3 Coverage and extent

North Sea: All data within the research area are captured, also when only part of the area is recorded. Partial coverage and clouds can cause the inclusion of “no data” values. The data is presented in a continuous surface. Extent Cordis data:Xmin 213372.049 (Minlong –1 W)Ymin 5546300.847 (Minlat 50 N)Xmax 560746.624 (Maxlong 10 E)Ymax 6317830.529 (Maxlat 57 N). This map extent has the North Sea at its centre.

3.8.4 Spatial resolution and accuracy

The spatial resolution is 1 km2, Maximum scale for realistic use of mapdata is 1 km2 (e.g. the working scale or scale of data collection). The spatial accuracy is within the range of kilometers.

3.8.5 Temporal coverage, resolution, and accuracy

The data is continuously available since 1 Jan 2005. Temporal resolution is daily (parts of the North Sea are usually covered in several scenes per day). The data sets are acquired several times a week. (At present, there might be minor gaps in the data collections during holidays. Further automating of future versions will enable continuous datasets). This provides adequate temporal coverage to detect seasonal trends. The temporal accuracy is within the range of 5 minutes (10 minutes for composites).

3.8.6 Thematic resolution and accuracy

The thematic resolution, or differences in CHL concentration discerned is given as < 0.5 1 2 3 5 10 20 30 50 100 >100. This is conform the presentation of other CHL satellite products but might optimistic from a data quality point of view.

The thematic accuracy of standard CHL products in Case 2 (coastal) waters can be influenced adversely by in incorrect atmospheric correction, and the presence of high concentrations of other optical constituents, such as TSM and CDOM in addition to CHL, for coastal waters.

3.8.7 Spatial reference system

UTM 31 N (Universal Transverse Mercator in Zone 31North).

3.8.8 Formats

WATeRS data can be delivered in the following formats: Geotiff, ESRI ASCII grid, ESRI grid and rendered to the web client as gif or png image through the ArcIMS mapserver.

3.8.9 Restrictions on use and distribution

Please make reference to the WATeRS project in case of use and further distribution (in publications, on the Internet, CD-ROM, etc.). Reference: Eleveld, M.A., Wagtendonk, A.J., Pasterkamp, R., De Reus, N & Omtzigt, N. (2006). WATeRS: A portal for water quality information products from operational remote sensing. There are some limitations on commercial use, and on all access to the entire data. In case of doubt please contact Marieke.Eleveld@ivm.vu.nl.

4. Conclusions

The WATeRS portal, *http://ivm10.ivm.vu.nl/mapserver/waters/*, is an innovative customised ArcIMS-application with a WMS ArcIMS-OGC connector, developed at VU-IVM in a collaboration of Remote Sensing and SPINlab scientists.

We developed a generic method to convert satellite data (in scientific formats) to information in GIS formats. We serve this information, near-real time and interactively available for all on the Internet via a customised web service. The main result from a user point of view is this information service. On the long term this service will encourage WQ managers to use RS (products) for their monitoring purposes.

Lots of developments made in this project can be used for other (water quality) parameters and sensors. The developed and implemented services currently show only part of the application potential of both the remote sensing data, and the processing architecture behind this portal. Because the limited scope of the project more elaborated services such as those giving access to and analytical usage of WATeRS its database with historical data are not yet fully exploited.

On of the main strengths of WATeRS is that it's a near-real time. This also means that WATeRS needs to be updated continuously. This can easily be automated.

Another conclusion is that if no other sponsor is found, the WATeRS Portal cannot continue in the current form, which is a purely sponsored service. Two forms of paid WATeRS Portal services are identified: a paid service operated by the IVM (which is preferred by the developers) and one operated in co-operation with IVM by a third party, a commercial company.